ROYAL ASTRONOMICAL SOCIETY.

VOL. XIII. *June* 10, 1853. No. 8.

G. B. AIRY, Esq., President, in the Chair.

P. Kernan, Esq., 21 Clifford Street, Bond Street;
Dr. Roxburgh, 38 Gloucester Place, Portman Square;
E. H. R. Coleman, Esq., 9 Wood Street, Cheapside; and
Thomas Finch, Esq., 5 Promenade Villas, Cheltenham,

were balloted for and duly elected Fellows of the Society.

Sig. Secchi, Director of the Observatory of the Collegio Romano at Rome, and
M. Yvon Villarceau, of Paris,

were duly elected Associates of the Society.

Discovery of a New Comet. By M. Klinkerfues.

On the 10th of June, M. Klinkerfues, at the Observatory of Göttingen, discovered a small comet with a tail 3′ or 4′ long. The following are the observed positions :—

1853.	M.T. Gött. h m s	R.A. h m s	Decl. ° ′ ″	Stars of Comparison.
June 10	13 0 53·6	9 31 53·77	+43 28 17·1	Lalande, 18953
11	11 25 3·0	9 32 29·97	+43 23 57·9	— 19022

For elements and an ephemeris of this comet, see *Ast. Nach.* No. 864, p. 390.

Observations of a Comet made on board H. M. S. Centaur, by Lieut. Goodenough, R.N.

(*Extract of a Letter to the Astronomer Royal.*)

"As it appears to me that the following observations of a comet seen here may not be uninteresting, I beg to enclose them.

"The comet was first seen at $6^h\ 45^m$ p.m. April 30, a little south-west of *Orion*, bearing west-south-west. Its nucleus was very distinct from the coma, and shone as a star between the 3d and 4th magnitude. The coma extended (by estimation) about 2′ round the nucleus; and the tail, pointing nearly direct to the zenith, had a length of about 4°, its width increasing but little.

" An observation was taken as follows, at a little after seven p.m.,—

Green. M.T.	True Dist. for Sirius.	True Dist. for Castor.
h m s	° ′ ″	° ′ ″
11 9 37	34 43 50	58 22 33

" Both observations are corrected for refraction, they give a R.A. $4^h\ 22^m\ 20^s$, and Decl. 6° 45′ 2″ South.

" The evening of May 1 was cloudy, and only one observation could be obtained, at

Green. M.T.	True Dist. from Rigel.
h m s	° ′ ″
11 32 2	5 12 30

the comet being in a direct line with λ *Leporis* and *Rigel*.

" The mail leaves this evening, so I send these two; in the event of obtaining any further observations to-night, I will send them. I believe you prefer to receive the observations themselves. I have therefore sent them corrected only for refraction.

" *H.M.S. Centaur, Buenos Ayres, Outer Anchorage, May* 2, 1853."

" Our position is four miles north-east of the fort of Buenos Ayres."

Remarks on Saturn as seen with the Madras Equatoreal (by Lerebours and Secretan; focus, 89 in., aperture, 6.2 in.) By W. S. Jacob, Esq., Director of the H. E. I. Co.'s Observatory, Madras.

The faint inner ring and the division in the outer ring were both seen with power 365, on 24th August, 1852, soon after the arrival of the new object-glass (the original one having been defective), and they have been viewed on various subsequent occasions with powers from 174 to 365; the fine outer division can, under favourable definition, be traced through more than one-half the circumference; its breadth cannot be estimated at more than one-third or one-fourth of the large division, say 0″·1. The faint ring as projected on the planet has a filmy appearance, and the planet is seen through it as through a film of smoke; it has an umber brown tint; off the planet it has a slaty hue. The large division is also decidedly not black, but little, if at all, darker than the faint ring as seen on the planet, and of about the same tint; its inner edge is pretty sharp, but its outer edge seems rather shaded off. No belts were seen on *Saturn*, except the broad bright equatoreal one; the whole south hemisphere being shaded or mottled over not quite uniformly, but a little darker next the white belt, and also in slight cloudy patches here and there, especially towards the pole. The shadow of the planet on the ring is very black and sharp. An eclipse of *Tethys* is thought to have been seen on 5th January. The satellite had been tolerably conspicuous near the western ansa, but as *Saturn* neared the zenith, it was noticed as fainter, and on looking for it a few minutes later it could not be seen. The time of disappearance would be about $2^h\ 10^m$ Madras

sidereal time, but with an uncertainty of several minutes. The satellite was seen again at about 5^h, nearly opposite *Saturn's* north pole.

The following are the results of four nights' measures, reduced to *Saturn's* mean distance (9·5430, according to Bouvard's tables), powers used 365, 365, 277, 277. Mean date of observation, 1853·0123, Greenwich mean time.

	″
Outer Diameter of Outer Ring	39·91
Diameter of fine Division	38·09
Inner Diameter of Outer Ring	35·40
Outer Diameter of Inner Ring	34·67
Inner Diameter of Inner Ring	26·32
Inner Diameter of Faint Ring	22·19
Equatoreal Diameter of Saturn	17·86
Polar Diameter of Saturn	16·51
Breadth of large Division	0·37
Minor Axis of Outer Ring	14·33

Saturn's equatoreal diameter was corrected for phase (0″·04.) The above measures agree moderately well with Struve's, as given in *Ast. Soc. Mem.* vol. iii. p. 299, but differ considerably from the values in the *Nautical Almanac.* My breadth of the interval between the rings is 0″·04 less than Struve's, and is decidedly too small (owing to the shading off of the outer edge noticed above), the apparent breadth being *estimated* at fully 0″·5, or little, if at all, less than the thickness of the micrometer wires which is 0″·6. I have not been able to make out any other marks or divisions in the ring than those mentioned above.

On the Parallax of α Herculis. By W. S. Jacob, Esq.

(*Extract of a Letter to the Rev. R. Sheepshanks.*)

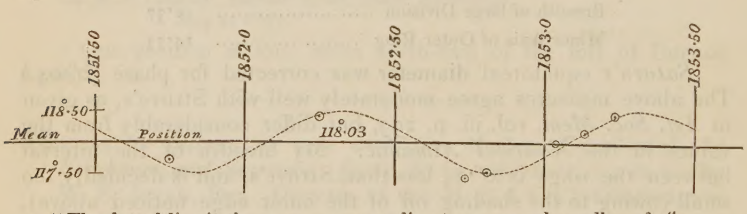
" I write in haste to save a mail, and give you early notice of my observations of α *Herculis*, proving, as I think, the existence of a parallax of about 0″·06. I send only the mean results, and a rough tracing of the curve, as the details will appear in the forthcoming volume of our *Memoirs;* but it is desirable that the attention of astronomers should be called to the star, and that my results should if possible be confirmed by some one else. I am just leaving Madras for the hills on account of my health, so that my observations will be interrupted, but I hope to take the subject up again on my return.

" The following are my mean results. You see the course of the curve is pretty well represented, not only by the observations near the extreme points, but also by the intermediate ones. The observations of distance are, of course, not exact enough for detecting so small a quantity, but their evidence is at least not contradictory. The instrument used was the Lerebours' equatoreal (89 in. focus, $6\frac{1}{4}$ in. aperture), power in the two first sets 200, being

the highest the maker had furnished with his micrometer. The remainder were taken with a Dollond's micrometer (kindly lent by General Fraser), and with powers of 277 and 365. By far the greater number of observations were by daylight, or I doubt if they would have given such consistent results.

Epoch.	Position.	No. of Obs.	Distance.	No. of Obs.
	°		″	
1851·753	117·73	20	4·57	30
1852·252	118·43	25	4·45	30
·736	117·44	25	4·38	24
·801	117·59	35	4·60	42
1853·039	118·03	21	4·54	18
·127	118·13	23	4·63	24
·268*	118·52	26	4·46	26

" Epochs for greatest effect of parallax on the position, ·327 and ·835, or 30th April and 1st November.



" The dotted line is the curve corresponding to an annual parallax of 0″·059.

" *Observatory, Madras, April 12th*, 1853."

On the Determination of the Latitude of the Liverpool Observatory by means of Observations made in the Prime Vertical. By John Hartnup, Esq.

A short time subsequent to the establishment of the Liverpool Observatory, W. H. Simms, Esq., the present Surveyor-General of Ceylon, in a letter which I received from him, incidentally mentioned that he had been getting some observations on the prime vertical for latitude, and that he had found so convenient a formula for correcting the errors in the position of the transit instrument that he could apply it to all stars, whether high or low, with almost the same results. At my request he very kindly sent me the formula, and I applied it in the reduction of a series of observations taken with a transit placed nearly in the prime vertical, for the purpose of determining the latitude of the Liverpool Observatory. This formula has not, I believe, been published; and, with the permission of the author, I, therefore, beg to present it to the Royal Astronomical Society, together with fifty-eight results of co-latitude, in the reduction of which it has been employed.

The following are the formulæ which I received from Mr. Simms:—

* Includes an additional observation taken this morning, 13th April.

φ, the co-latitude of the place of observation.
π, the polar distance of a star observed on the east vertical.
π', — — — west vertical.
H, the hour-angle of the star observed east.
h, — — — west.
μ, the inclination of the axis of the instrument, positive when the south end is the highest.
ν, the azimuthal deviation from the prime vertical, supposed to be small.

$$\left.\begin{aligned}\tan k &= \tan \pi \,.\, \cos \mathrm{H}\\ \sin \psi &= \sin \pi \,.\, \sin \mathrm{H}\end{aligned}\right\} \quad \left\{\begin{aligned}\tan k' &= \tan \pi' \,.\, \cos h\\ \sin \psi' &= \sin \pi' \,.\, \sin h\end{aligned}\right.$$

$$\nu = \frac{\cos \psi \,.\, \cos \psi' \,.\, \tan (k' - k)}{\sin (\psi + \psi')}$$

$$\varphi = k \pm \mu \pm \tan^{-1} (\nu \,.\, \tan \psi).$$

In the determination of the Valentia Arc of Longitude a very fine portable transit instrument of $3\frac{1}{2}$ feet focal length and $2\frac{1}{2}$ inches aperture, made by Troughton and Simms, was used at the Valentia station. The instrument is the property of the Rev. R. Sheepshanks, who very kindly allowed it, on its return from Ireland, to be left at the Liverpool Observatory for the purpose of determining the latitude by transits over the prime vertical.

A massive stone pier for the reception of the equatoreal was at that time erected ; the walls of the equatoreal-room were built up, and a temporary covering of wood was thrown over the room. On this massive stone pier the portable transit stand was placed, and arrangements were made for me to walk around the instrument without stepping upon the pier. The transit instrument thus placed nearly in the prime vertical was within hearing of the sidereal clock, the error of which was determined by transits taken with the meridian transit instrument.

In order to give the method a fair trial I decided, previous to commencing the observations, that the following conditions should be complied with :—

1. That the time of taking each set of observations should not extend beyond an interval of a few hours ; this was done with the view of guarding, as far as possible, against changes in the azimuthal position of the instrument.
2. That for each set, at least one star should be observed east, and one west, so that a good determination of the value of ν might be obtained.
3. That the instrument should be levelled as often as convenient during each set.
4. That every observation not made under favourable circumstances should be at once rejected, and not reduced.
5. That no observation made under favourable circumstances and reduced, should be rejected on the ground of discordance.

Agreeably to the above conditions, 58 transits over the prime vertical were observed and reduced, 22 over the west, and 36 over the east vertical. Sixteen different stars were observed, whose north polar distances range from 38° to 66°, and the extreme difference in colatitude between either of the 58 results and the mean result is only 2″·66, and there are 31 of the 58 results which do not differ from the mean to the amount of one second of arc. The places of the stars were all taken from the Greenwich 12-year Catalogue.

The following example, which is added as a specimen of the calculation, will show the great convenience of the method. The three stars observed followed each other so closely that the whole time occupied in observing them did not extend over an interval of ten minutes, and the latitude deduced from these three observations differs only from o″·37 from the mean of the 58 results.

1845, *February* 6. *Illuminated End of Axis South.*

	12 *Can. Ven.*, W.	β *Draconis*, E.	γ *Draconis*, E.
	h m s	h m s	h m s
Observed Transits	16 19 53·37	16 25 24·00	16 28 41·60
Clock slow	12·69	12·70	12·70
Transits corrected	16 20 6·06	16 25 36·70	16 28 54·30
App. R.A. of Stars.....	12 48 48·04	17 26 55·23	17 52 59·64
Hour-Angle in Time ...	3 31 18·02	1 1 18·53	1 24 5·34
h =	52° 49′ 30″·3	H = 15° 19′ 37″·95	H = 21° 1′ 20″·1
π' =	50 50 58·7	π = 37 35 7·0	π = 38 29 37·0

ν *determined by* 12 *Can. Ven.*, W., *and* γ *Draconis*, E.

$\tan \pi' = 0{\cdot}0893017$	$\sin \pi = 9{\cdot}9005058$	$k' = 36° 34′ 57″·56$
$\cos h = 9{\cdot}7812169$	$\cos H = 9{\cdot}9700869$	$k = 36\ 35\ 14{\cdot}41$
$\tan k' = 9{\cdot}8705186$	$\tan k = 9{\cdot}8705927$	$k' - k = -16″{\cdot}85$
$\sin \pi' = 9{\cdot}889578$	$\sin \pi = 9{\cdot}794089$	$\cos \Psi = 9{\cdot}988895$
$\sin h = 9{\cdot}901346$	$\sin H = 9{\cdot}554768$	$\cos \Psi' = 9{\cdot}895560$
		$\tan k' - k = 5{\cdot}912175$
$\sin \Psi' = 9{\cdot}790924$	$\sin \Psi = 9{\cdot}348857$	$5{\cdot}796630$
		$\sin (\Psi + \Psi') = 9{\cdot}890905$
$\Psi' = 38° 9′ 49″$	$\Psi = 12° 54′ 7″$	$\log \nu = 5{\cdot}905725$

12 *Can. Ven.*

$k' = 36° 34′ 57″·56$	$\tan \Psi' = 9{\cdot}895364$
$\tan^{-1} (\nu \cdot \tan \Psi) = +13{\cdot}05$	$\log \nu = 5{\cdot}905725$
$\mu = -{\cdot}85$	$5{\cdot}801089$
$\varphi = 36\ 35\ 9{\cdot}76$	

γ Draconis.

k	$= 36^\circ\ 35'\ 14''{\cdot}41$	$\tan \psi$	$= 9{\cdot}359961$
$\tan^{-1}(\nu \cdot \tan \psi)$	$= -\ 3{\cdot}80$	$\log \nu$	$= 5{\cdot}905725$
μ	$= \quad -{\cdot}85$		$5{\cdot}265686$
ϕ	$= 36\ 35\ 9{\cdot}76$		

β Draconis.

$\tan \pi$	$= 9{\cdot}8863183$	$\sin \pi$	$= 9{\cdot}785288$	$\tan \psi$	$= 9{\cdot}213154$
$\cos \cdot H$	$= 9{\cdot}9842717$	$\sin H$	$= 9{\cdot}422149$	$\log \nu$	$= 5{\cdot}905725$
$\tan k$	$= 9{\cdot}8705900$	$\sin \psi$	$= 9{\cdot}207437$		$5{\cdot}118879$
k	$= 36^\circ\ 35'\ 13''{\cdot}80$	ψ	$= 9^\circ\ 16'\ 41''$		
$\tan^{-1}(\nu \cdot \tan \psi)$	$= \quad -2{\cdot}71$				
μ	$= \quad -{\cdot}85$				
ϕ	$= 36\ 35\ 10{\cdot}24$				

In the determination of ϕ in the above example, it has been assumed that the instrument was free from error of collimation. I had no means of determining the error of collimation except by observations of stars made with the illuminated end of the axis north and south alternately, and it was found to be desirable to observe sets in both positions of the instrument, over three, five, and sometimes seven wires, and consequently the collimation differed in these different sets. In the above example, the stars were observed over three wires, and the collimation for three wires, with the illuminated end of the axis south, was found to be $+2''{\cdot}73$, therefore $2''{\cdot}73$ must be added to the results in the above example.

When a star passes the prime vertical at 50° or 60° from the zenith, a small error either in the assumed place of the star or in the observed transit, will affect the latitude considerably; and as a general rule it may, perhaps, be desirable to use very low stars for the purpose of determining the azimuthal deviation only. The following table has been compiled from the partial results in order to show the resulting latitude from each star:—

	N.P.D. ° ′	Latitude. ° ′ ″	No. of Obs.
β Draconis	37 35	53 24 48·03	4
ℓ Ursæ Majoris	37 37	46·92	4
γ Draconis	38 29	48·15	4
η Ursæ Majoris	39 55	46·78	2
α Persei	40 42	46·49	10
ι Ursæ Majoris	41 22	46·83	1
Capella	44 10	47·72	6
β Aurigæ	45 5	48·65	1
α Cygni	45 16	47·59	4
12 Can. Ven.	50 51	47·54	4
α^2 Geminorum	57 47	48·17	3
ζ Cygni	60 24	48·34	5
β Tauri	61 32	48·88	4
β Geminorum	61 36	48·22	3
α Andromedæ	61 66	49·87	2
ε Leonis	65 31	48·68	1

The mean latitude from all the observations $=53^\circ\ 24'\ 47''{\cdot}72$. The latitude of the transit instrument of the Liverpool observatory, by the Ordnance Survey, $=53^\circ\ 24'\ 46''{\cdot}34$ by the first method, and $53^\circ\ 24'\ 46''{\cdot}45$ by the second method. The position from which the transits over the prime vertical were taken is six feet south of the meridian transit instrument.

*Latitude of the Liverpool Observatory, deduced from Transits over the Prime Vertical.**

Date.	Name of Star.	Illuminated End of Transit Axis.	Vertical.	Hour Angle observed.	Azimuthal Deviation Correction.	Level Correction.	Collimation Correction.	Co-Latitude.
1844.				° ′ ″	″	″	″	° ′ ″
Dec. 20	ζ Cygni	S	W	65 2 40·35	−61·31	−0·64	+3·07	36 35 13·44
	Capella	...	E	40 10 52·20	+24·09	...	...	11·86
	β Aurigæ	...	E	42 15 34·95	+25·92	...	...	11·35
	β Geminor.	..	E	66 21 41·85	+65·14	...	...	13·43
	α^2 Geminor.	...	E	62 7 31·35	+53·92	...	...	11·99
	s Leonis	...	E	70 15 48·60	+79·46	...	...	11·32
	α Persei	...	W	30 18 18·75	−16·68	...	...	12·16
30	β Tauri	N	E	66 15 15·45	−31·75	−0·22	−3·07	11·35
	α Persei	...	E	30 18 20·85	− 8·34	−0·06	...	13·69
	ζ Cygni	...	W	65 4 9·30	+30·96	+0·14	...	11·26
	Capella	...	E	40 9 6·75	−12·87	+0·92	...	11·57
	β Geminor.	...	E	66 20 6·30	−37·38	+1·87	...	11·67
	α^2 Geminor.	...	E	62 5 51·45	−31·12	+2·07	...	13·83
1845.								
Jan. 11	α Persei	S	E	30 18 40·20	−10·56	+2·02	+3·55	13·74
	Capella	..	E	40 9 15·60	−15·24	+2·96	...	12·87
	β Geminor.	...	E	66 20 11·25	−41·24	+3·30	...	10·25
	α Androm.	...	W	66 31 4·80	+41·57	+3·42	...	10·38
	α Persei	...	W	30 20 3·60	+10·56	+3·80	...	13·30
	ι Ursæ Maj.	...	E	32 30 51·90	−11·50	+4·22	...	13·17
12	α Cygni	N	W	42 40 20·40	+26·23	−0·56	−3·55	14·32
	β Tauri	...	E	66 14 43·35	−64·69	−0·70	...	12·06
	α Persei	...	E	30 17 41·85	−16·63	−0·80	...	14·14
	ζ Cygni	...	W	65 4 39·90	+61·22	+0·03	...	12·56
	Capella	...	E	40 8 33·00	−24·94	+0·07	...	10·26
	α^2 Geminor.	...	E	62 5 25·80	−55·83	+0·73	...	9·67
	α Androm.	...	W	66 31 20·70	+68·04	+0·94	...	9·88
	α Persei	...	W	30 19 54·00	+17·30	+1·78	...	13·70
18	β Tauri	S	E	66 15 7·35	−49·28	+0·69	+3·55	9·64
	α Persei	...	E	30 18 27·00	−12·67	...	...	13·77
	ζ Cygni	...	W	65 4 37·65	+46·63	...	...	9·62
	α Persei	...	W	30 19 54·00	+12·68	...	...	36 35 14·76

* The original of the annexed table contained a column exhibiting the uncorrected co-latitude, which has been omitted for want of space.

Date. 1845.	Name of Star.	Illuminated End of Transit Axis.	Vertical.	Hour Angle observed.	Azimuthal Deviation Correction.	Level Correction.	Collimation Correction.	Co-Latitude.
				° ′ ″	″	″	″	° ′ ″
Jan. 22	β Tauri	N	E	66 14 30·60	−79·11	−0·35	−3·55	36 35 11·42
	α Persei	...	E	30 17 30·00	−20·34	...	...	13·66
	ζ Cygni	...	W	65 4 56·40	+74·89	...	...	11·42
	α Persei	...	W	30 20 0·75	+20·36	...	...	12·19
30	β Draconis	S	E	15 18 55·80	− 9·63	+3·52	+2·73	12·14
	γ Draconis	...	E	21 0 44·10	−13·51	+1·78	...	10·32
	α Cygni	...	E	42 38 46·65	−32·40	+2·38	...	11·41
	β Draconis	...	W	15 21 19·80	+ 9·66	+1·78	...	10·81
31	12 Can.Ven.	N	W	52 50 5·25	+37·82	−0·43	−2·73	10·25
	β Draconis	...	E	15 18 17·70	− 7·85	−0·44	...	11·98
	γ Draconis	...	E	21 0 7·95	−11·01	−0·44	...	12·02
	α Cygni	...	E	42 38 45·15	−26·42	+0·69	...	11·36
Feb. 4	α Cygni	N	E	42 39 3·00	−16·23	−1·48	−2·73	12·56
	γ Draconis	...	W	21 1 42·30	+ 6·77	−1·48	...	12·56
6	12 Can.Ven.	S	W	52 49 30·30	+13·05	−0·85	+2·73	12·49
	β Draconis	...	E	15 19 37·95	− 2·71	...	...	12·97
	γ Draconis	...	E	21 1 20·10	− 3·80	...	...	12·49
April 7	Capella	N	W	40 9 33·60	+ 4·37	+0·21	−4·09	13·85
	ℓ Ursæ Maj.	...	E	15 35 12·00	− 1·41	...	...	12·64
	12 Can.Ven.	...	E	52 48 34·95	− 6·83	...	...	13·86
	ℓ Ursæ Maj.	...	W	15 35 29·40	+ 1·45	...	...	13·18
	η Ursæ Maj.	...	W	27 27 17·55	− 2·69	...	...	12·98
8	Capella	S	W	40 9 49·95	+ 1·11	+1·30	+4·09	13·25
	ℓ Ursæ Maj.	...	E	15 36 23·10	− 0·37	...	...	13·32
	12 Can.Ven.	...	E	52 48 57·75	− 1·74	...	...	13·25
	ℓ Ursæ Maj.	...	W	15 36 29·85	+ 0·37	...	...	13·17
	η Ursæ Maj.	...	E	27 27 59·85	− 0·69	...	...	36 35 13·45

Hence mean value of co-latitude = 36° 35′ 12″·28
and latitude ..... = 53 24 47·72

Liverpool Observatory, 1853, *May* 31.

At the meeting of the Society, held on the 13th of May, a letter was read which Captain Manners had recently received from Mr. Wackerbarth of Upsala, containing information respecting the present state of astronomy in Sweden, and also some interesting particulars relative to the ancient observatory of Tycho Brahé in the Island of Huena.

Extract of a Letter from Sig. Secchi to Capt. R. H. Manners, R.N.

"I have lately received the interesting Memoir of M. Otto Struve on the rings of *Saturn*, and I have sought whether the ancient observations of Campani and the early Italian astronomers confirm what has been found by him, that the dark space between the ring and the planet formerly appeared larger than now, and I have found from a figure of Campani that this is really the fact. The figure, of which I send you the original, shows also a faint shadow as a vestige of the inner dark ring which has been lately discovered.

"*Rome, May* 24, 1853."

[The drawing of *Saturn* above referred to by Sig. Secchi, may be seen at the apartments of the Society. It is stated underneath that it was executed by Campani in the year 1664. The maximum breadths of the ring, and of the interval between the ring and the ball, measured roughly with a pair of compasses, appear to be *exactly equal*. The faint shading indicative of the obscure ring is seen *immediately contiguous* to the bright ring at the part where the latter crosses the body of the planet.]

Note on Professor Powell's Communication in the last Number of the Notices, p. 221.

Since the publication of the *Notice* referred to, the author has become acquainted with an apparatus on the same principle as that he has described, though differing in the details of its construction, which is more complex, invented by Bonenberger; a modification of which has been employed in Magnus's researches on some phenomena of rotatory motion in projectiles (see Taylor's *Foreign Scientific Memoirs*, N. S. part iii. p. 223). An apparatus somewhat of the same kind, he is also informed, is in the collection at King's College, London.

June 13, 1853.

Occultation of o Tauri observed at Ashurst. By Robert Snow, Esq.

(N. Lat. 51° 15′ 58″. W. Long. $1^m\ 10^s{\cdot}0$.)

	h	m	s		
Immersion	6	23	30	Corrected sidereal time.	Bright limb
Emersion	7	33	15	— —	Dark limb

Immersion not good. Emersion very good.

Nov. 27, 1852.

On the Determination of the Longitude of the Observatory of Cambridge by means of Galvanic Signals. By G. B. Airy, Esq., Astronomer Royal.

The President resigned the Chair to Dr. Lee, and then gave a *vivâ-voce* account of the operations for determining the Longitude of the Observatory of Cambridge by Galvanic Signals.

The object for which the galvanic connexion of the Royal Observatory with the London Bridge Railway Station was originally proposed, was the determination of differences of longitude with other observatories, British and Continental. Till within a short time, however, the connexions have been made available, principally, for the transmission of daily signals at certain definite hours along the principal Railways of England: for the dropping of the Signal Ball mounted by the Electric Telegraph Company on the roof of their Office in the Strand: and for the maintenance of the movement of several sympathetic Clocks, one of which is at the London Bridge Station. As soon, however, as the proper turn-plates were mounted at the Royal Observatory, and other details of mechanical arrangement were completed, experimental comparisons were made (comparing the transit-clock at the Royal Observatory with a chronometer at London Bridge, with one at Dover, &c.) in order to learn by experience the most advantageous method of conducting the operation for a real determination of difference of longitude.

The wire from London to Greenwich used in these operations is susceptible of such connexions, that its current may be made to pass through the coils of a telegraph needle which is fixed on the case of the transit-clock, and thus to the earth. This is the connexion which is used when signals are to be received from a distant station. The wire also admits of such connexion that the galvanic circuit, interrupted at one place in the Royal Observatory, passes from the earth through a galvanic battery, then through the coils of the telegraph-needle, then (with an interruption as is mentioned above) to London; and the interruption may be destroyed, or the circuit completed, either (on one arrangement of turn-plates) by an apparatus similar to that of the common speaking-telegraph; or (on another arrangement of turn-plates) by a contact-piece on the eye-end of the transit-circle, which is intended ultimately for use in the American method of recording transits. In either of these cases, if the London or distant end of the wire communicates through the coils of a telegraph-needle to the earth, the completion of the circuit at Greenwich will produce a movement both in the needle at Greenwich and in that of the distant station.

The arrangement of Greenwich turn-plates which, in fact, was used in the observations to be described, was that in which the circuit is completed at the eye-end of the transit-circle. And some of the signals given did actually correspond to the transits of stars over wires of the transit-circle, as observed by the signal-giver, whose eye was applied to the eye-piece, while with his finger he made the contact with the contact-piece.

In the arrangement which has been described, it will be perceived that nothing depends on the accuracy of the signal-giver. It is his business to complete the circuit, and thus to give signals at certain approximate times; but by this operation needle-signals, similar in all essential respects, are given both at Greenwich and at the distant station; and if observers are stationed to observe the motions of the needles, the comparison of the clocks will depend

on the accuracy of these signal-observers only, who are under the very favourable circumstance of observing signals of similar character at both ends of the line. In order to give to these observations all practicable accuracy, it is desirable that the signal-giver should be at a distance from the signal-observer; and even that, if possible, he should be in another room.

The arrangements made at the distant stations were formed on the same principles, and, in fact, approached very nearly to those which have been described as applying to Greenwich. In one respect, however, they were necessarily less perfect: in no other place is the galvanic-needle carried by the transit-clock; and it was necessary, therefore, at other places to use another clock or chronometer, which was compared by means of transportable chronometers with the transit-clock.

The preceding description shows that at each station it is necessary to have a signal-giver (A) and a signal-observer (B). But it was also found advantageous to employ a third person (C), on account of the following arrangement. The plan adopted as most convenient was, that the signal-giver should fix, in his mind, upon any arbitrary number of signals for each "batch!" and that he should give notice of this number of signals to the signal-observers at both ends by giving the same number of warning-signals at intervals of about 2^s; (3^s is better for a long line.) It was the duty of (C) to watch and count these warning-signals, and then to say "There are [so many] signals coming;" he then remained silent while the signals, at intervals of 10^s to 15^s, were observed by the signal-observer; and when the just number was completed he called out, "The batch is finished." This left the signal-observer (B) free to examine the seconds on the dial, to write down the minutes, and generally to prepare himself for the next batch.

Supposing the signals given in equal numbers from the two ends of the line, the signal-giver (A) at each end was employed during only half the time; but (B) and (C) at each end were employed through the whole time.

The order of operations then, as between Greenwich and Cambridge, was as follows:—

At 11^h p.m. Greenwich Mean Solar Time, Greenwich commenced by giving five signals at intervals of about 2^s each. The turn-plates were changed, and Cambridge responded by five similar signals. These were merely to say "All is right." Then Greenwich gave batches of signals as above described, in numbers of from three to nine signals in a batch (some of them being transits of stars), to $11^h\ 15^m$. Then Cambridge gave similar batches to $11^h\ 30^m$. Then Greenwich gave signals to $11^h\ 45^m$, and Cambridge to $12^h{\cdot}0$. This closed the night's signals. From 135 to 150 efficient signals were given; and as the observation of a signal is perhaps rather less accurate than the observation of a transit-wire, the probable error of the mean of these will be fairly comparable with that of the determination of clock-error in an evening's transits.

The evenings selected for the determination of the longitude of Cambridge were those of 1853, May 17 and 18. Mr. Walker,

Engineer and Superintendent of Telegraphs of the South-Eastern Railway, undertook to make the circuit perfect in every respect from Greenwich to Lothbury; and Mr. Edwin Clark, Engineer of the Electric Telegraph Company, provided carefully for the junctions at Lothbury and the Eastern Counties' station, and for the instrumental and personal aid required at the Cambridge station. To these gentlemen the thanks of Astronomers are due; not simply for their assistance in the present operation, but for the energetic assistance which they have given in the important work of placing the Royal Observatory in galvanic connexion with the rest of England, and making its determinations of time generally useful. Professor Challis arranged the more strictly astronomical part of the operation, in the following manner. On May 17, Mr. Dunkin observed transits and galvanic signals at Greenwich, and Mr. Todd observed at Cambridge. On the morning of the 18th the observers were interchanged, and Mr. Todd observed transits and signals at Greenwich, while Mr. Dunkin observed at Cambridge. The errors of the transit-clocks were determined by two methods: method (A) in which the *Nautical Almanac* stars were employed, the same corrections being applied to the right ascensions of the *Nautical Almanac* for both observatories, but no particular care being taken for the identity of the stars at the two stations; and method (B), in which the clock was corrected by stars in a list suggested by Professor Challis, the same stars being observed at both stations, but no attention being given to the accuracy of the assumed Right Ascensions.

For comparison of the Cambridge transit-clock with the chronometers used at the Railway Station, Professor Challis employed three chronometers. It was found necessary to reject the comparisons of one of these.

It is unnecessary to say that every care was given to the determination of the instrumental errors of the transit-instruments at both stations. At both stations, transits were observed both before and after the galvanic signals, on both evenings. The number of battery-cells used at each station was 72. The air was dry, and the insulation was good.

The results of the operation are as follows:—

East Longitude of Cambridge.

Method (A).

	s
May 17, by 145 signals	22·953
May 18, by 134 signals	22·978
Mean	22·966

Method (B).

	s
May 17, by 145 signals	22·903
May 18, by 134 signals	22·988
Mean	22·946
Mean of the whole	22·956

This is probably one of the most accurate determinations of difference of longitude hitherto made.

The result arrived at in 1829, by transmission of chronometers, was $23^{s}.54$.

The President then stated that on May 25 signals were passed (in exactly the same manner) to and from Edinburgh, for the determination of the longitude of Edinburgh Observatory, and, as regarded the galvanic part of the operation, with perfect success. There was, however, something suspicious in the indications of one of the chronometers employed at Edinburgh, which threw doubt on the clock-comparisons, and rendered the apparent determination of difference of longitude doubtful. The following result however was obtained, which is free from the influence of uncertainty in the chronometer-rate; that when a signal is given at Greenwich, by means of a Greenwich battery, the time noted for the signal at Edinburgh is later than that noted at Greenwich by $\frac{1}{17}$th of a second of time (and *vice versâ* if the signal is given at Edinburgh by means of an Edinburgh battery). This difference probably arises from two causes: first, the time actually occupied by the transmission of the galvanic pulse, which, according to the American determinations, would explain less than half of the difference; secondly, the circumstance that the galvanic current when it reaches the distant needle is somewhat less vigorous than when it passes the nearer needle, and the languid movement of the distant needle catches the eye more slowly, and is recorded as occurring at a later time.

In reply to a remark by Mr. R. C. Carrington, on the influence of the length of the transit telescope upon the determination of clock error, the President stated that the length of the Greenwich transit telescope is less than 12 feet, and that at Cambridge 10 feet, and that no sensible error would result from that cause.

On Certain Results of Laplace's Formulæ, expressing the Relation between the Inclinations, Excentricities, and other Elements of the Planetary Orbits. By Dr. Lardner.

In this paper the author shows that the well-known formulæ of Laplace,

$$\Sigma\,(m\sqrt{a}\,e^2) = c \qquad \text{(I)}$$

$$\Sigma\,(m\sqrt{a}\tan^2 i) = c' \qquad \text{(II)}$$

would not of themselves suffice to assure the stability of the planetary system in the sense in which the term is usually applied. By a very simple process he demonstrates that for anything contained in these theorems to the contrary, the excentricities of all the planets which revolve within the orbit of *Jupiter* may attain any magnitude whatever, that their several orbits may actually become

hyperbolic, and that although the formula (II) certainly imposes major limits upon the inclinations, these limits are in some cases so considerable as to be inconsistent with the stability of the planetary system as usually understood.

We shall obtain the numerical value of the constant c by calculating severally the products $m \cdot \sqrt{a} \cdot e^2$ for each of the planets; but in the case of the group of small planets between *Mars* and *Jupiter*, their masses being undetermined, cannot with any arithmetical precision enter into this calculation: it is evident, however, that, from their extreme minuteness, they will produce a very inconsiderable effect upon the value of c. It may be sufficient for the present purpose to suppose the group to be replaced by a single planet, having a mass equal to that of the earth, an excentricity equal to that of *Mars*, and a mean distance $= 2{\cdot}6$. If this be assumed, and the several products $m \sqrt{a}\, e^2$ be calculated from the tables of the planetary elements, we shall find the following numerical results:—

	$m \sqrt{a}\, e^2$.
Mercury	0·00000001298
Venus	10
Earth	79
Mars	400
Planetoids	3947
Jupiter	504525
Saturn	277266
Uranus	38197
Neptune	2219
$\Sigma (m \sqrt{a}\, e^2)$	= 0·00000827941

It appears, therefore, that

$$c = 0{\cdot}00000827941.$$

If it be desired then to ascertain the greatest possible excentricity of each planet which is compatible with this constant value of c, it will only be necessary to suppose that $e = 0$ for all the other planets. That will give

$$e'^2 = \frac{c}{m' \sqrt{a'}},$$

where e' is the excentricity, m' the mass, and a' the mean distance of the planet, whose limiting excentricity is sought.

If, then, we substitute in this formula the numerical value of c determined above and the values of e, m, and a for each of the planets severally, we shall find the major limits of the values of e for the planets, including the imaginary planets taken to represent the group of planetoids.

	Major limit of e.
Mercury	5·192
Venus	1·976
Earth	1·714
Mars	4·240
Planetoids	1·350
Jupiter	0·0617
Saturn	0·0970
Uranus	0·2170
Neptune	0·1684

It appears, therefore, that for all the planets included within the orbit of *Jupiter*, the major limits of e are greater than 1, and, therefore, the excentricities are susceptible of all possible values between 0 and 1 and of all values between 1 and the several limiting values given above.

It follows from all this that, consistently with the conditions involved in the formula (I), the orbits of these planets may be ellipses of any degree of excentricity from the circle to the most flattened oval, and that they may be even hyperbolas, for which e would have any values between 1 and the several numbers given in the preceding table.

In the case of the four superior planets, *Jupiter*, *Saturn*, *Uranus*, and *Neptune*, the formula does impose such narrow limits upon their excentricities as must effectually guarantee their stability and the uniformity of their climatological conditions.

The formula

$$\Sigma\,(m\,\sqrt{a}\tan^2 i) = c'$$

is subject to precisely the same observations.

By substituting, as before, the values of m, a, and i, for each of the planets taken from the tables of the elements, we shall obtain the values of the products $m\,\sqrt{a}\,\tan^2 i$ for the planets severally, and by their addition we shall obtain the numerical value of their constant sum. Thus we obtain:—

$$\Sigma\,(m\,\sqrt{a}\tan^2 i)\ldots\ldots = 0{\cdot}000003\,14170$$

To find the limiting value of each inclination it will be sufficient, as before, to suppose all the orbits but the one whose limiting inclination is sought to coincide with the plane of the ecliptic. If, then, m', a', and i, express the mass, mean distance, and inclination of the planet whose limiting inclination is sought, we shall have

$$\tan^2 i = \frac{c'}{m'\,\sqrt{a'}}.$$

Now, by substituting in these successively for m' and $\sqrt{a'}$ their values for each of the planets, we shall obtain the limiting values of the inclination, which will be as follows:—

	Limit of i.
	° ′
Mercury	72 38
Venus	50 36
Earth	46 34
Mars	69 3
Planetoids	39 45
Jupiter	2 11
Saturn	3 25
Uranus	7 37
Neptune	5 56

It appears, therefore, that in this case, as in that of the excentricities, the conservative influence of the formula only bears upon the outer group of planets, and that the inclinations of the inner group are liable, so far as they are restricted by this formula, to a range of variation altogether incompatible with all idea of conservation.

[Laplace, in the Memoir in which he first announced the theorems above referred to (*Mém. Acad. des Sciences*, 1784), remarked that the results of his researches on the secular variations of the planetary movements (to which these theorems formed direct corollaries) assured the permanent oscillation of the excentricities and inclinations of the orbits within comparatively narrow limits; and this statement was repeated by him in much more explicit terms in the *Mécanique Céleste* (tome i. liv. ii., tome v. liv. xv.) It is important to bear in mind, however, that, although these theorems do not imply quite so much as has been ascribed to them, this circumstance does not in the slightest degree impugn the researches of geometers on the stability of the planetary system. Lagrange, by a comprehensive investigation of the subject, first determined the actual limits within which the planetary orbits would oscillate from the mutual action of the disturbing bodies (*Mem. Acad. Berlin*, 1782), and the researches of that great geometer have been perfected and extended in recent times by M. Le Verrier. Laplace, in the Memoir already referred to, showed that the expressions for the secular variations of the excentricities and inclinations of the planetary orbits would consist of a series of terms involving the sines and cosines of angles proportional to the time, but would not contain any term involving the time either in an algebraic or an exponential form; and as he supposed the coefficients of the various terms to be small from the nature of the problem, he hence concluded that both the excentricities and the inclinations would perpetually oscillate between narrow limits. These researches were subsequently published in an improved form in the *Mécanique Céleste*, but on neither occasion were the actual limits of the excentricity or the inclination in any individual case determined; nor is any allusion made in the latter work to the remarkable researches of Lagrange on this subject, either in the first volume, wherein the subject of

the secular variations is formally investigated, or in the fifth volume, containing historical notices of the labours of Newton and his successors on the theory of gravitation (with the exception of perhaps a very obscure allusion to the subject at page 319 of tome v.) It may be stated that the inadequacy of the analysis of Laplace, to establish the stability of the planetary orbits individually, without having recourse to numerical calculation, had been already pointed out by Le Verrier and others (*Comptes Rendus*, 1840, 1^ier^ Semestre, p. 526).—R. G.]

Results of Micrometrical Measures of Double Stars made at Tarn Bank, Cumberland, from 1850·2 *to* 1853·4. By Isaac Fletcher, Esq., F.R.A.S.

The author commences his paper, by referring the reader to the tenth volume of the *Monthly Notices*, for a description of the instrumental means employed by him in obtaining the micrometrical measures here presented to the Society.

The telescope employed is a 6-foot achromatic refractor of 4·14 inches aperture, mounted equatoreally in the English fashion on a polar axis of mahogany, and driven by clock-work. The mounting, in fact, appears to be almost precisely similar to those of the instruments of Mr. Bishop, Lord Wrottesley, and the one which formerly belonged to Admiral Smyth, but which now adorns Dr. Lee's Observatory at Hartwell. The object-glass seems to be of first-rate excellence, as is abundantly shown by the measurement of such stars as *ζ Herculis*, *δ Cygni*, &c., and by the fact that, under favourable circumstances, it bears a power of 600. The measures have all been executed with a parallel wire micrometer, and a deep red illumination of the field of view. The hour-circle is *loose* on the polar axis,—an arrangement which appears to be convenient and advantageous, and Mr. Fletcher strongly recommends its general adoption. The entire instrument is the workmanship of Mr. Cooke of York. The catalogue of observations incorporates about 5200 *individual* measures, which are represented by about 280 *sets* of measures, most of the sets containing eight measures of position and *sixteen* measures of distance. In consequence of the greater liability to error in observing distances, Mr. Fletcher seems to have taken great pains to insure good results by a large accumulation of measures of this element.

Stars of an ascertained binary character seem chiefly to have occupied Mr. Fletcher's attention; and, accordingly, the catalogue contains numerous observations of *γ Virginis*, *ξ Ursæ*, 70 *Ophiuchi*, *Castor*, *ζ Herculis*, and other stars of interest. The catalogue is followed by a synopsis of *final* mean results.

Mr. Fletcher gives notes on some of the more remarkable objects to which his measures have reference, comparing his results with those obtained by other astronomers.

We here insert some of these notes:—

36 *Andromedæ.* Σ 73.

This object has changed its position nearly 30° since it was first measured by Struve, and possibly the distance may have very slightly increased since that time, as it was occasionally *separated* by my refractor.

		Position		Distance	
Struve.....	1832·14		307°·80		0″·847
Dawes, B*	1841·81	—	320·75		1·076
Fletcher	1851·93	—	336·38	—	1·116

γ *Andromedæ.* Σ 205.

I was induced to pay considerable attention to this star, because Captain Smyth's measures seemed to indicate a pretty regular increase in distance. My result, however, is smaller than any of the Captain's. During the measures my instrument showed a slight elongation of the companion in the direction 116° ∓, and in November 1851 I saw it *completely divided* in Mr. Pattinson's magnificent refractor of $7\frac{1}{4}$ inches aperture.

μ *Canis Majoris.* Σ 997.

I have no doubt a change has taken place both in angle and distance, since Struve discovered this very beautiful but somewhat difficult object.

		Position		Distance	
Struve	1831·20		343°·53		3″·223
Smyth	1834·15	—	342°·9	—	3″·5
Mädler.....	1844·17	—	340°·80	—	3″·133
Fletcher	1852·60	—	338°·07	—	2″·947

The angle seems retrograding and the distance diminishing

Castor. Σ 1110.

My observations compared with other recent ones of this object, show that the distance is still slightly augmenting, and the angular motion diminishing, thus showing the general accuracy of the orbits which have recently been calculated by Mr. Hind and M. Mädler. The angles deduced from my observations are not, however, very closely represented by M. Mädler's ephemeris, as will be seen from the following comparison,—

	Observed.		Calculated.	
	Pos.	Dist.	Pos.	Dist.
1851·04	248°·67	5″·074	−2°·45	−0″·098
1852·04	247°·97	5″·074	−2°·36	−0″·077

That this difference is not attributable to much extent to error

* The "B" attached to some of the results by Mr. Dawes, signifies that they were obtained in Mr. Bishop's observatory.

in any observed angles, is shown by the correspondence of my first result with that of Mr. Dawes for the same year, which is,—

1851·21 Position 248°·12 Distance 5″·068

γ Virginis. Σ 1670.

In 1851 I calculated an orbit for this star, which is published in vol. xi. of the *Notices* of the Society. Since then I have obtained additional measures for two years, and using all other results that have come to my knowledge combined with my own, I have proceeded on Sir John Herschel's graphic process, and arrived at the following orbit, which scarcely differs from my previous one:—

Perihelion Passage	1836·40
Inclination	27° 36′
Position of Ascending Node	19 7
Angle between Lines of Nodes and Apsides	295 13
Excentricity	0·8794
Period in Years	184·53

It is extremely desirable that all observers of double stars should devote the most careful and unremitting attention to this star; and if this be the case, I believe, as Capt. Smyth remarked in a letter to me, "The epoch of 1857 will find the excentricity, inclination, perihelion passage, and period, all in unison." It is very satisfactory to find how closely my result for 1852 corresponds with those of Mr. Dawes and Mr. Miller, all being taken independently and without concert. I subjoin the three results:—

Miller	1852·26	Position 175°·28	Distance 3″·122
Dawes	1852·32	— 175·27	— 3·016
Fletcher	1852·42	— 175·40	— 3·147

ζ Herculis. Σ 2084.

Of late years this extraordinary star has become comparatively of easy measurement in *position*, and I have considerable confidence in my results. As its period is probably shorter than that of any other known binary star, it is very desirable that it should be well watched *now* when it is within the reach of ordinary telescopes. I have computed the elements of its orbit, by Sir John Herschel's method, and have obtained the following results:—

Perihelion Passage	1830·56
Inclination	140° 39′
Position of Node	217 14
Angle between Lines of Nodes and Apsides	266 53
Excentricity	0·4381
Period in Years	37·21

The period in this case, as well as in that of γ *Virginis*, was obtained by cutting the ellipse out of card-board, and weighing the different portions of it in a delicate balance. Mr. Bishop, in his invaluable volume of observations, has pointed out how enormously in some instances, the angles obtained by different observers about the same epoch differ from each other. It is, therefore, satisfactory to find recent observations agreeing more closely, as will be seen from the following comparison of observations for 1852 :—

		Position	Distance
Fletcher	1852·64	83°·97	1″·242
Dawes	1852·73	— 82°·52	— 1″·567
Miller	1852·77	— 84°·07	

Mr. Fletcher's paper concludes with a summary of the results of a series of double-star operations carried on in the years 1851 to 1853 at Whitehaven, by J. F. Miller, Esq., F.R.S. These results all relate to objects included in Mr. Fletcher's catalogue, and they have been obtained by an instrument of the same size as Mr. Fletcher's, though differently mounted. It is also the workmanship of Mr. Cooke.

Micrometrical Measures of ξ Ursæ Majoris, made at the Observatory, Whitehaven. By J. F. Miller, Esq. F.R.S.

Magnitudes, $4\frac{1}{2}$, 5. Both stars white.

No.	Position.	Weight.	Obs.	Distance.	Weight.	Obs.*	Epoch.
	° ′			″			
119	119 36	3	8	2·962	2	8	1853·082
121	118 46	2	8	2·991	4	8	·189
122	118 7	4	8	2·974	4	8	·191
131	118 52	4	8	3·097	4	8	·191
Means	118 47	13	32	3·012	14	32	1853·190
Means	122 17	20	57	2·898	18	52	1852·129

Notes on the Experiences of W. S. Jacob, Esq., H. E. I. Co.'s Astronomer, with the new Madras Equatoreal. By Professor Piazzi Smyth.

Having been favoured in my private correspondence with Mr. Jacob during the last year with many particulars of his observations beyond those contained in his recently communicated paper to the Royal Astronomical Society, and as some of these particulars have a high importance when taken in connexion with the observations of other astronomers, recently published in the *Monthly Notices*, and others again are highly worthy of the at-

* "The distances represent double measures, consequently each set really consists of sixteen observations."

tention of good observers during the ensuing season, an immediate publication appears desirable.

The instrument employed was an equatoreal, recently added to the establishment of the Madras Observatory by the liberality of the Hon. East India Company, and carrying a telescope with a 6-inch object-glass, of 7·5 feet focus; the magnifying power most frequently used was 270, Mr. Jacob always preferring as low as possible compatible with the matter on hand. The polar axis was of the long English form, with the telescope in the middle, on a short double transit-axis; everything being of metal, by MM. Lerebours and Secretan of Paris.

The original order for the instrument was given several years since at a time when it appeared to be thought by the practice of private observers, as well as several public ones, that good telescopes were only procurable at Munich. But in addition to disapproving of the principle of the Munich form of mounting, both Mr. Jacob and myself, to whom he intrusted the order, at that time a private one, had a repugnance to lend any countenance to a monopoly, kept up, generation after generation, not so much by the fair means of superior skill and workmanship as by the unfair means of the conservation of a secret of manipulation. Secrets are radically opposed to the principles of science and the practice of scientific men; and opticians who, in making an object-glass, are profiting by the thousand freely published discoveries of scientific men, are not acting rightly in keeping secret their own single discovery. They even, thereby, retard the improvement of the telescope; for there can be no doubt that were the Munich secret published, it would soon be improved and enhanced by the varied genius and ideas of all other men, just as Daguerre's discovery was so greatly advanced within a few months after its publication, though he had brought it to the ultimate perfection of his own mind, and, as he erroneously thought, the final completion of the thing itself. Even in ordinary trade and manufactures, secretiveness is exploded everywhere, except, perhaps, amongst the most ignorant of uneducated workmen; and a free interchange of ideas as well as commodities is recognised as the surest means of advancement. By no means, then, can concealment be allowed to predominate in the most scientific of all manufactures, and my friend and myself accordingly determined, at least, to try whether a first-rate object-glass could not be procured anywhere else than at Munich.

Attracted to MM. Lerebours and Secretan,* both by much previous fame, as well as by the lowness of their prices, we found all their instrumental work of the first quality; and though the first object-glass failed, the second, which had been tested at the Edin-

* At the time of the order being given, 1847, it was believed that a sufficiently good telescope could not be made in this country, and that, perhaps, was the reason why the Liverpool observatory was furnished with a Munich object-glass. Now, however, matters are improved, and several makers have distinguished themselves, Mr. Cooke, of York, perhaps chiefly, judging from published observations.

burgh observatory previously to being sent out to India, has proved equal, if not superior, to anything which could have been expected, from the published performances of telescopes of equal size by other makers.

An approximate trial of the new object-glass was made by Mr. Jacob on its arrival at Madras in August 1852, on several double stars with the following results :—

λ *Ophiuchi* divided by one diameter of B.

τ *Ophiuchi* clearly divided.

Antares, companion immediately discovered ; its previous detection in America not being then known in Madras.

μ *Boötis* elongated.

ζ *Boötis* well divided.

B of γ *Andromedæ*, sufficiently elongated to get a fair measure.

ω *Leonis* elongated.

No great importance is to be attached to these observations, as they were hastily made without waiting for any nights of remarkably good definition ; and I have no recent measures of the objects by other observers to compare them with ; but, on reference to my father's cycle, it will be seen that the object-glass may certainly rank amongst the first, and go forward to a further trial.

Such a one is presented by certain features of the planet *Saturn*, which has been an object of constant observation to some of our best telescopes and most practised observers during the past winter. A planet in general is certainly no accurate test of defining power, unless there be some special test-objects upon it; and the fine division of the outer bright ring of *Saturn* is exactly this species of proof; and as difficult for the telescope as the fine markings on the "navicula" for the achromatic microscope.

Such a fine division has been from time to time suspected by several observers, but was always so faint, and seen through such a small portion of the circumference, and at so very few and such distant intervals of time, that where its existence was believed in at all, it was thought to be temporary, or at all events to vary in width and consequent visibility. If this be true, the same epoch of time must be employed in the comparison of telescopes, and I limit myself, therefore, to the observations of last winter.

The best 6-inch object-glass that Munich has ever produced is probably that in the possession of the Rev. W. R. Dawes, probably also our best observer. By his letters in the *Monthly Notices*, during the last winter, he appears to have had a faint suspicion of traces of the fine division about the ansæ, but has not subsequently insisted upon it. At the same time, Mr. Lassell, with his splendid reflecting telescope, with its mirrors never better, in the clear climate of Malta, and with the planet at a greater height, represents himself as certain that there is no such division. But at the very same time, Mr. Jacob, with *Saturn* certainly a few degrees higher, after very careful adjustment of the focus, immediately saw the fine

division, and continued to see it during the seven months of the planet's apparition, on every night he looked, except one or two of bad definitions; with powers varying from 170 to 370. It was seen too, moreover, through more than half the circumference of the ring, and with abundant certainty to admit of micrometer measurement.

This certainly appears the most satisfactory account we have ever had of the fine division, especially as the rings are not yet at their maximum inclination; and while it indicates that the notion of the variable breadth of the separation may have been too freely drawn upon, it certainly proves Lerebours' object-glass to give much better definition than Mr. Lassell's speculum, and probably better than Mr. Dawes' Munich object-glass, unless a very wide margin be left for the effect of the different altitudes of the planet at the two places.

Amongst many other features in the appearance of the planet, mentioned by Mr. Jacob, are the transparency of the dark ring, and its brown colour by the transmitted light of the planet, which are both mentioned in a letter, dated Madras, Oct. 10, 1852, and referring to the appearance of the planet on Sept. 22, 1852. He also mentions a suspicion of a sort of scalloping, like the fold of a curtain, on the inner ansæ of the dark ring, and finds the principal division of the bright ring to be filled with a half-luminous medium, and shaded off so much on one edge as to make the accurate measure of its breadth very doubtful.

There can, however, be no doubt of the glasses of the telescope being very transparent, as well as defining well.

Mr. Jacob having lately commenced the regular observation of a selection of double stars, with a view to parallax, though with little hope of success; inasmuch as though this was the final object in view, for which they were taken up by Sir W. Herschel and other observers, no one has yet succeeded in finding the desired quantity. Mr. Jacob was, therefore, unexpectedly pleased at finding, towards the end of last year, that the components of *α Herculis* showed evident symptoms of parallax.

[Professor Smyth then gives the details of Mr. Jacob's observations, which, being similar to those mentioned at page 242, need not be repeated here. He concludes his paper by stating that, as the components of *α Herculis* form one of the most remarkable pairs in the sky for contrasted colours, they may thereby serve to indicate the colour of the medium pervading space.]

On the Corrections to be applied to Burckhardt's and Plana's Parallax of the Moon, expressed in terms of the Mean Arguments. By J. C. Adams, Esq., M.A.

In the Supplement to the *Nautical Almanac for* 1856, I have given new tables of the moon's parallax, adapted to Burckhardt's

form of the arguments. When the arguments have been already computed, these tables supply the most convenient means of finding the parallax, and they have, accordingly, been used in calculating the corrections to the *Nautical Almanac* Parallaxes since 1840, given in the paper above referred to.

When, however, Burckhardt's arguments are not previously known, it will be more simple to employ arguments increasing proportionably to the time, in order to calculate either the parallax itself immediately, or the correction to be applied to that found from Burckhardt's tables.

The following formulæ may be used for this purpose, the arguments being expressed in Damoiseau's notation.

The moon's equatoreal horizontal parallax, or, more strictly, the *sine* of that quantity converted into seconds of arc is equal to

$$
\begin{aligned}
&3422''{\cdot}32 + 186{\cdot}51 \cos x + 10''{\cdot}17 \cos 2x + 0''{\cdot}63 \cos 3x + 0''{\cdot}04 \cos 4x \\
&-0''{\cdot}95 \cos t + 28''{\cdot}23 \cos 2t + 0''{\cdot}26 \cos 4t \\
&\qquad + 34''{\cdot}30 \cos (2t - x) + 0''{\cdot}37 \cos (4t - 2x) \\
&-0''{\cdot}40 \cos z + 1''{\cdot}92 \cos (2t - z) + 1''{\cdot}45 \cos (2t - x - z) \\
&+1''{\cdot}16 \cos (x - z) - 0''{\cdot}71 \cos (2y - x) - 0''{\cdot}95 \cos (x + z) \\
&+0''{\cdot}01 \cos (x - t) - 0''{\cdot}31 \cos (2x - 2t) \\
&-0''{\cdot}31 \cos (2t + z) - 0{\cdot}23 \cos (2t - x + z) \\
&-0''{\cdot}11 \cos (2y - 2t) + 0''{\cdot}22 \cos (2t + x - z) - 0''{\cdot}12 \cos (3x - 2t) \\
&+0''{\cdot}14 \cos (t + z) + 3''{\cdot}09 \cos (2t + x) + 0''{\cdot}60 \cos (4t - x) \\
&-0''{\cdot}11 \cos (t + x) + 0''{\cdot}28 \cos (2t + 2x) \\
&+0''{\cdot}12 \cos (2x - z) - 0''{\cdot}10 \cos (2x + z) + 0''{\cdot}09 \cos (2t - 2z) \\
&-0''{\cdot}09 \cos (2y + x - 2t) + 0''{\cdot}05 \cos (2t - x - 2z) \\
&+0''{\cdot}06 \cos (4t - x - z).
\end{aligned}
$$

Also, the correction to be applied to the equatoreal horizontal parallax found from Burckhardt's tables is

$$
\begin{aligned}
&1''{\cdot}79 + 0''{\cdot}13 \cos x + 0''{\cdot}06 \cos 2x + 0''{\cdot}14 \cos 3x + 0''{\cdot}04 \cos 4x \\
&+0''{\cdot}06 \cos t + 0''{\cdot}05 \cos 2t - 0''{\cdot}29 \cos 3t + 0''{\cdot}17 \cos 4t \\
&\qquad - 0''{\cdot}18 \cos (2t - x) + 0''{\cdot}01 \cos (4t - 2x) \\
&+0''{\cdot}05 \cos z + 0''{\cdot}93 \cos (2t - z) + 1''{\cdot}15 \cos (2t - x - z) \\
&+0''{\cdot}07 \cos (x - z) - 1{\cdot}50 \cos (2y - x) \\
&-0''{\cdot}05 \cos (x - t) + 0''{\cdot}02 \cos (2x - 2t) \\
&-0''{\cdot}90 \cos (2t + z) - 1''{\cdot}17 \cos (2t - x + z) \\
&-0''{\cdot}12 \cos (2y - 2t) + 0''{\cdot}12 \cos (2t + x - z) + 0''{\cdot}10 \cos (3x - 2t) \\
&+0''{\cdot}14 \cos (t + z) + 0''{\cdot}09 \cos (2t - 2z) - 0''{\cdot}06 \cos (2y + x - 2t) \\
&+0''{\cdot}05 \cos (2t - x - 2z) + 0''{\cdot}07 \cos (2x + z - 2t) \\
&-0''{\cdot}09 \cos (2t + x - 2y)
\end{aligned}
$$

In both the above formulæ, quantities less than $0''{\cdot}05$ have been neglected, except where they can be included in the same table with larger terms.

When Burckhardt's parallax is known, it will be sufficient for ordinary purposes to calculate the correction to be applied to it, taking into account only the constant term, and the periodic terms depending on the arguments,

$$x,\ t,\ 2t-x,\ 2t-z,\ 2t+z,\ 2t-x-z,\ 2t-x+z,\ 2y-x,\ t+z.$$

If extreme accuracy be required, the parallax should be calculated afresh by means of the first of the above formulæ.

These formulæ, as well as my tables in the Supplement to the *Nautical Almanac for* 1856, give the value of the *sine* of the parallax, converted into seconds of arc, which is frequently more convenient for use than the parallax itself.

To find this latter quantity, we must add

$$0''\cdot16 + 0''\cdot03 \cos x.$$

Plana's formula for the parallax, as given in the Introduction to the Greenwich Lunar Reductions, also requires several corrections, partly in consequence of the developements not having been carried far enough, and partly from errors in the numerical conversion of the analytical expression.

The constant of parallax employed in the Lunar Reductions appears to be Henderson's, or $3421''\cdot8$; and the computed quantity is taken to be the parallax itself.

The correction to be applied to the parallax thus found, in order to make it agree with my determination, is given by the following formula :—

$$\begin{aligned}
&0''\cdot68 - 0''\cdot16 \cos x - 0''\cdot13 \cos 2x + 0''\cdot03 \cos 3x + 0''\cdot04 \cos 4x \\
&-0''\cdot05 \cos t + 0''\cdot63 \cos 2t + 0''\cdot16 \cos 4t \\
&+0''\cdot40 \cos (2t-x) + 0''\cdot07 \cos (4t-2x) \\
&-0''\cdot28 \cos (2t-z) - 1''\cdot91 \cos (2y-x) + 0''\cdot29 \cos (2t+z) \\
&+0''\cdot01 \cos (x-t) - 0''\cdot51 \cos (2x-2t) \\
&+0''\cdot09 \cos (2y-2t) + 0''\cdot14 \cos (t+z) + 0''\cdot10 \cos (4t-x) \\
&-0''\cdot11 \cos (t+x) - 0''\cdot02 \cos (2t+2x) \\
&+0''\cdot12 \cos (2x-z) - 0''\cdot10 \cos (2x+z) + 0''\cdot09 \cos (2t-2z) \\
&-0''\cdot09 \cos (2y+x-2t) + 0''\cdot05 \cos (2t-x-2z) \\
&+0''\cdot06 \cos (4t-x-z)
\end{aligned}$$

As before, quantities less than $0''\cdot05$ have been neglected, except when they unite with larger terms.

In the American *Nautical Almanac for* 1855, recently published, Plana's formula for the parallax appears to have been employed; the constant, however, being slightly altered.

The following table, which Mr. Farley has obligingly calculated at my request, shows the corrections to be applied to the parallaxes given in this work, in order to make them agree with those found from my tables.

Differences of Moon's Hor. Par. as given in the American N. A. from that obtained from Mr. Adams' Tables.

1855. G. M. Noon of each Day.

Day of Mth.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	″	″	″	″	″	″	″	″	″	″	″	″
1	−1·5	−3·1	−2·2	−0·6	+0·8	+1·6	+1·4	−0·2	−2·3	−2·6	−3·3	−1·3
2	1·7	3·4	2·2	0·6	0·8	1·2	0·9	1·1	2·9	2·9	3·3	0·9
3	2·4	3·4	2·2	0·8	0·4	0·8	+0·2	1·9	3·6	3·2	3·1	−0·5
4	2·9	3·9	2·6	1·0	+0·2	0·3	−0·5	2·6	3·9	3·7	2·4	+0·1
5	3·3	4·0	2·8	1·2	0·0	+0·1	1·0	3·0	4·1	3·5	1·7	0·5
6	3·5	3·8	2·7	1·1	−0·2	−0·1	1·6	3·6	4·0	3·3	1·1	0·7
7	3·6	3·3	2·5	0·8	+0·2	0·2	1·8	3·8	3·8	2·8	−0·4	1·4
8	3·3	2·6	2·2	−0·2	0·5	0·4	2·1	3·8	3·3	2·0	+0·5	2·1
9	3·3	2·0	1·8	+0·5	0·8	0·6	2·4	3·8	2·8	1·2	1·0	2·2
10	3·0	1·5	1·1	1·1	0·8	0·7	2·5	3·4	2·3	−0·4	1·5	2·2
11	2·5	1·2	−0·4	1·3	0·7	0·9	2·5	3·1	1·8	+0·4	1·6	1·5
12	2·2	0·8	0·0	1·3	0·6	1·2	2·5	3·0	1·2	0·7	1·4	+0·6
13	1·8	−0·2	+0·4	1·4	0·5	1·5	2·6	2·7	0·6	0·8	0·8	−0·5
14	1·2	+0·4	0·8	1·2	+0·3	2·0	2·9	2·4	−0·2	0·9	+0·3	0·8
15	−0·4	1·1	1·2	1·2	0·0	2·4	2·9	2·0	+0·1	0·9	−0·2	1·1
16	+0·5	1·7	1·3	0·8	−0·6	2·7	3·0	1·7	0·3	0·8	0·6	1·7
17	1·1	1·8	1·5	+0·4	1·2	3·0	2·9	1·3	0·5	0·7	0·9	2·1
18	1·3	1·2	1·6	−0·3	1·9	3·0	2·6	0·8	0·5	0·4	1·4	2·3
19	1·2	+0·5	0·9	1·0	2·5	3·0	2·0	0·4	0·4	+0·1	1·7	2·6
20	0·7	−0·4	+0·5	1·9	2·8	2·7	1·8	0·4	0·1	−0·5	2·2	3·0
21	+0·1	1·2	−0·4	2·4	2·8	2·4	1·5	0·0	+0·1	1·0	2·4	3·1
22	−0·4	1·9	1·2	2·7	2·7	2·1	0·9	−0·1	−0·2	1·4	2·3	2·5
23	1·0	2·4	1·8	2·7	2·3	1·5	0·4	+0·3	0·1	1·3	2·2	2·0
24	1·3	2·8	1·9	2·5	2·0	1·0	−0·1	0·6	0·0	1·3	1·7	1·5
25	1·5	2·8	2·1	2·2	1·6	−0·2	+0·4	0·9	0·0	1·0	1·3	1·4
26	1·7	2·7	2·5	1·8	1·1	+0·6	1·1	1·3	0·1	1·1	0·8	1·2
27	1·8	2·5	2·5	1·2	−0·3	1·0	1·8	1·3	0·5	1·3	0·9	0·6
28	2·2	−2·5	2·1	0·7	+0·5	1·9	1·9	+0·7	0·9	1·5	1·3	0·9
29	2·3	...	1·7	−0·1	1·5	2·4	2·1	0·0	1·4	1·7	1·2	−0·5
30	2·6	...	1·4	+0·4	1·9	+2·1	1·6	−0·7	−1·9	2·4	−1·4	0·0
31	−2·8	...	−1·1	...	+1·9	...	+0·7	−1·6	...	−2·7	...	+0·8

The constant employed in the computations of the American *Nautical Almanac* does not appear to be mentioned in the Preface. It may, however, be determined in the following manner:—

The sum of the daily corrections given in the above table is −370″·4. Now, I find that −14″·1 of this is due to the corrections applied to the periodic terms, leaving −356″·3 as the effect caused

by the difference of the constants. This, divided by 365, gives $-0''.98$ as the correction to be applied to the constant of the American *Nautical Almanac*, in order to make it agree with my own. Hence, this latter value being $3422''.32$, it follows that the constant employed in the above work is $3423''.30$.

Report of the Astronomer Royal to the Board of Visitors. Read at the Annual Visitation of the Royal Observatory, Greenwich, 1853, June 4.

In this Report the Astronomer Royal exhibits the state of the Observatory on 1853, May 22, and records generally the principal occurrences from 1852, May 18, to 1853, May 22.

Under the head of *Grounds and Buildings*, an account is given of the progress of operations for forming a galvanic communication between the Observatory and other places of importance, both in this country and on the Continent. The communication with the various parts of the British Isles is maintained by means of wires passing from the Observatory to the South Eastern Railway Terminus at London Bridge. With respect to the Continent, this is effected by forming a connexion between the Observatory and the wires of the Submarine Telegraph Company, which pass underground from London to Dover. One of the Company's wires was cut where it crosses Blackheath, and the interrupted segments were continued by branches to a turn-plate, which is contained in an iron box fixed in the south wall of the Park. From this turn-plate a wire is led into the transit circle-room of the Royal Observatory. By different adjustments of the turn-plate, communications are made between London and Paris, between London and Greenwich, or between Greenwich and Paris. This part of the Report concludes with the statement that the Observatory now possesses the means of communicating with every part of Great Britain and of the Continent.

The Moveable Property, the Manuscripts, and the Library of the Observatory, are next noticed in succession. With respect to the Manuscripts, it is stated that Professor De Morgan has recently transmitted to the Observatory a considerable number of letters found in the collection of correspondence of the late Mr. Baily. These letters are, doubtless, calculated to throw much valuable light upon the scientific history of the age in which Mr. Baily lived; and on this account they cannot fail to be hereafter consulted with advantage.

Astronomical Instruments.—The condition of the various instruments is noticed under this head, and appears to be satisfactory. With respect to the recording of transits by the aid of galvanism, the following statement is made:—"The Barrel Apparatus for the American method of observing transits is not yet brought into use. In an apparatus, embodying much that is new (for the

circumstances under which we have to try it differ much from those of the original experiments) there must be a great many small alterations; and sometimes from the demand for workmen competent to perform work of this kind, a single alteration has caused more than a month's delay. I have, however, brought it to such a state that I am beginning to try whether the barrel moves with sufficient uniformity to be itself used as the transit clock. This, if perfectly secured, would be a very great convenience; but I am not very sanguine on that point. Much convenience will, however, be gained by making the barrel to move with a speed approaching very near to uniformity, even though the barrel-clock be not quite accurate enough to be used as the best measurer of time in the Observatory, and, therefore, not accurate enough to be used for impressing the second-dots upon the barrel."

Observations.—No alteration has been made in the general system of meridian observations. The observation of the moon on the meridian is never omitted; that of the sun and planets only on Sundays. The whole number of observations from 1852, May 18, to 1853, May 22, is nearly as follows:—In the transit department: transits, 4037; observations of collimators, 312; observations of transit wire by reflexion, 312; observations of one collimator by the other, 52. In the meridian circle department: observations of all kinds, 4475.

The Reflex Zenith Tube has been in active use during the past year. Between May 18 and October 20, 106 single observations have been obtained with it.

The Altazimuth has been used in precisely the same manner as in the preceding years. The number of days of complete observations of the moon is 224, or 18 per lunation, against 106 with the transit-circle, or $8\frac{1}{2}$ per lunation. Of the altazimuth observations, 0 are when the moon passed between 0^h and 1^h, 4 between 1^h and 2^h, 8 between 2^h and 3^h, 8 between 3^h and 4^h, 6 between 20^h and 21^h, 0 between 21^h and 22^h, 1 between 22^h and 23^h, 1 between 23^h and 24^h. In none of these positions, except on a single occasion between 20^h and 21^h, was the moon observed on the meridian. The whole number of separate observations of moon and stars with the Altazimuth is 1003; and the whole number of separate observations of its collimator, 712.

The South Equatoreal has been used only for images of the solar spots. The Double-Image Micrometer has been employed in executing measures of *Venus*, *Saturn* and his Rings, and γ *Virginis*.

The Reduction and Printing of the astronomical observations are next noticed in the Report. The advanced state of the Reductions (although not so close as usual, in consequence of a serious diminution of the strength of the establishment arising from the illness of several of the assistants) is attributed chiefly to the order and energy of Mr. Main. Allusion is then made to the operations connected with the Magnetical and Meteorological departments of the Observatory.

Chronometers, Communications of Time, and Operations for Longitude. — Under this head various interesting facts are detailed. "The number of chronometers now on hand," it is stated, "is 120. The system of rating the chronometers daily or weekly, as the case appears to require, of reporting the rates to the Admiralty, of rating the trial-chronometers in extremes of heat and cold, of abstracting their rates, of superintending repairs, and of dropping the signal-ball, remains unaltered. In the mechanical part of the operation of rating, an alteration has been made which contributes greatly to convenience, and in some measure to accuracy. At the time of the Visitors' last meeting, a normal clock had been erected by Mr. Shepherd, furnished with a small apparatus suggested by myself (an auxiliary pendulum, which can be made very long or very short, and can in either state be connected with the clock-pendulum), by means of which the indication of the clock can be increased or diminished by any required quantity above $0^s.01$. The error of this clock being ascertained every day, by means of another clock close to its side, which has been compared with the transit-clock, there is no difficulty (with the use of the auxiliary apparatus above-mentioned) in making it sensibly correct. This clock keeps in motion a sympathetic galvanic clock in the chronometer-room, which, therefore, is sensibly correct; and thus the chronometers are compared with a clock which requires no numerical correction. I need not insist on the facility, and the freedom from a fruitful source of errors, which are thus obtained.

"The same normal clock maintains in sympathetic movement the large clock at the entrance-gate, two other clocks in the Observatory, and a clock at the London Bridge Terminus of the South-Eastern Railway (first tried with the assistance of C. V. Walker, Esq., as an experiment, but now to be used for automatically making and unmaking certain connexions of our galvanic wires). It sends galvanic signals every day along all the principal railways diverging from London. It drops the Greenwich ball, and the ball on the offices of the Electric Telegraph Company in the Strand; and the correctness of the last of these operations is tested by means of a galvanic signal-needle upon the case of our transit-clock. All these various effects are produced without sensible error of time; and I cannot but feel a satisfaction in thinking that the Royal Observatory is thus quietly contributing to the punctuality of business through a large portion of this busy country.

"I have the satisfaction of stating to the Visitors that the Lords Commissioners of the Admiralty have decided on the erection of a time-signal-ball at Deal, for the use of the shipping in the Downs, to be dropped every day by a galvanic current from the Royal Observatory. The construction of the apparatus is intrusted to me. Perhaps there is no roadstead in the world in which the knowledge of true time is so important."

The operations for the determination of longitudes by means of electric signals are then referred to. The details with respect to

Cambridge and Edinburgh have been already mentioned in the lecture of the Astronomer Royal at the last meeting of the Society.* With respect to the Oxford Observatory, Mr. Airy stated that the wires for connecting the Observatory with the Railway Station at Oxford are nearly completed, so that the determination of the longitude of the Observatory by galvanic signals may be expected at no distant date.

The galvanic determination of the longitude of the Royal Observatory of Paris and of other Continental observatories relative to Greenwich, will constitute the natural sequel to these operations.

After a brief allusion to the personal establishment of the Observatory, the author of the Report proceeds to notice the "*Extraneous Computations.*" Under this head it is stated that the revision of the Star Results of Dr. Maskelyne is now completed, and a hope is justly expressed that "it will be found that the publication of these deductions will give most valuable information on the state of the sidereal heavens from 1765 to 1807."

A proposal is next made respecting the Observations of the Moon. The great work on the Lunar Reductions terminates with the year 1830. The theory employed in computing the tabular places of the moon, with which the results of observation were compared, was mainly that of Plana. In recent years (from the beginning of 1836) the places of the moon deduced from the observations have been compared with the corresponding places in the *Nautical Almanac*, calculated from Burckhardt's Tables; but, as the latter have been found by Mr. Adams to be sensibly erroneous, in so far as regards the parallax, the Astronomer Royal suggests whether it would not be desirable at once to complete the reduction of the observations and their comparison with tables, from 1831 to 1851; using, as far as possible, in all respects the same bases of reduction of observations and the same elements of tables as in the former Lunar Reductions.

The Report concludes with some general remarks relative to the present satisfactory condition of the Observatory.

Astronomische Beobachtungen auf der Sternwarte zu Bonn augestellt und herausgegeben von Dr. F. W. A. Argelander. Zweiter Bund, Zonenbeobachtungen am Südhimmel. Zweiter Abtheilung. 4to. pp. 427. Bonn, 1852.

This volume forms the second part of M. Argelander's zone observations included between 15° and 31° of south declination. An account of the observations contained in the first part, including a statement of the general plan of the work, is given at page 26 of the present volume of the *Monthly Notices.* The zones in the part which has recently been published, as mentioned above, extend from No. 322 to No. 404.

* See p. 248.

Astronomical Observations made at the Radcliffe Observatory in the Year 1851. By Manuel J. Johnson, M.A., Radcliffe Observer. Vol. XII. 8vo. Oxford.

This volume contains the usual class of observations with the meridian instruments. These are followed by a catalogue of circumpolar stars observed in the year 1851. The number of stars is 2243. Mr. Johnson has not yet completed the entire series of observations for the Circumpolar Catalogue, as a considerable number of objects not included in the Catalogue of Groombridge require further revision. In the Circumpolar Catalogue of the present volume there will be found more than the usual number of stars within 5° or 6° of the pole. Mr. Johnson has for some years past bestowed great attention on the stars situate in that region of the heavens. The principal object which he had in view has been to supply ready means for determining the meridian error of the transit instrument, by observations of two such stars at their opposite culminations; a method which, after long trial, he recommends for its convenience and accuracy.

There are two Appendixes to this volume. Appendix I. contains "Remarks on the Application of the Heliometer to the Photometry of the Stars." The interest attached to the subject of this paper, and the valuable character of the results, render a separate account of it desirable, which will be found in a Supplement to the present *Notice*. Appendix II. consists of an Index, showing the volumes of the Radcliffe Observations, vol. i.–xii., in which observations of stars in Groombridge's Catalogue will be found.

A Supplement to No. 864 of the *Astronomische Nachrichten* contains a biographical notice of the late Professor Schumacher by M. Olufsen, accompanied with a lithographic portrait of the revered astronomer, and a fac-simile of his handwriting.

*** *Several Communications have been omitted in the present Number for want of space. These will shortly be published in a Supplement, which will also contain the Index and other particulars relating to the completion of* volume xiii. of the *Monthly Notices*.

London :—Printed by G. Barclay, Castle St. Leicester Sq.